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Optimal Public Deficit and Tax-smoothing in the Spanish Economy, 1850-2022

Emilio Congregado*, Vicente Esteve** and Maria A. Prats***

Abstract

In this paper we provide a formal test of Barro's tax-smoothing model, using Spanish data covering the period 1850–2022. First, we found that the tax-tilting component has been very important for the Spanish government and is a symptom of the existence of a public deficit bias that has existed in Spanish public finances over the sample period. Second, our empirical findings do also support the existence of tax-smoothing in Spanish fiscal policy throughout the sample period. Consequently, there is some evidence that the Spanish economy has engaged in tax-smoothing behaviour over the period analysed, as the Spanish governments responded to expected future changes in government spending by running budget imbalances, rather than altering contemporaneous government revenues.

Keywords: Optimal taxation; Public debt management; Tax-smoothing; Tax-tilting, Spain

JEL classification: E62, H21, H62, O52

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Optimal public deficit and tax-smoothing in the Spanish economy, 1850-2022

1. Introduction

Fatas et al. (2019) reveal that governments issue public debt for several reasons. On the one hand, the good reasons are, among others, intertemporal tax-smoothing, fiscal stimulus during economic downturns (the Keynesian view), and optimal asset management, including providing financial markets with safe assets. While such motives can explain some of the increases in public debt, particularly after wars or significant financial crises, they cannot plausibly account for all of the observed changes.

On the other hand, the bad reasons for borrowing are driven by political failures associated with intergenerational transfers, strategic manipulation, and common pool problems. Moreover, these political failures are a major cause of overborrowing, although budgetary institutions and fiscal rules can play a role in mitigating governments' tendencies to overborrow.

In particular, the tax-smoothing argument suggests that countries should accumulate public debt to finance large and lumpy expenditure (such as wars, natural disasters, and large investment projects), but also that debt accumulation during recessions should be accompanied by debt reduction in good times.

The concept of tax-smoothing, suggested in a seminal article by Barro (1979) and extended to more general settings by Lucas and Stokey (1983), has become one of the most important concepts with substantial policy implications in public finance. According to the tax-smoothing hypothesis (TSH), a deficit in the government budget can exist for at least two possible reasons: tax-smoothing and/or tax (shift) tilting. Under tax-smoothing, deficits are temporary phenomena resulting from the decision to not vary the tax rate in response to fluctuations in government spending[1]. This is done in order to minimize the distortionary cost of taxes. Specifically, tax-smoothing behaviour results in public deficits because, in the presence of non-lump-sum taxes, optimizing governments seek to minimize the distortionary effects of taxation by keeping tax rates smooth over time, rather than varying contemporaneously with expenditure. Even if we assume that expenditures will remain constant over time, precluding the need for tax-smoothing, fiscal deficits may arise due to tax-tilting behaviour if the government's discount rate differs from the effective interest rate, as then there is an incentive to tilt taxation across time.

Indeed, the Spanish case proves to be of particular interest given the permanent difficulties experienced when balancing the government budget across years, and it is also an interesting case study among eurozone countries. This is because the Spanish fiscal performance has been characterized by chronic government deficits and episodes with high levels of public debt, which is particularly dangerous when belonging to a monetary union.

In this paper we provide a formal test of Barro's tax-smoothing model, using Spanish data spanning the period 1850–2022. The scheme of the paper is as follows. The literature is selectively surveyed in Section 2. Section 3 introduces the theoretical model and the empirical implementation. The empirical results are presented in Section 4. Section 5 draws the main conclusions.

2. The empirical tax-smoothing literature

Considering the extant literature, empirical evidence of the TSH is relatively mixed. For example, Ghosh (1995) finds evidence supporting the TSH for Canada and the USA for the period 1961–1988. Additionally, Huang and Lin (1993) ascertain that the

[1] The tax-smoothing model is widely used in the literature to address various fiscal policy issues; see Sahasakul (1986), Bohn (1990), Trehan and Walsh (1990), Ghosh (1995), Angeletos (2002), Lloyd-Ellis et al. (2005), and Aiyagari et al. (2002). For the tax-smoothing setting with state-contingent debt, see Lucas and Stokey (1983) and Karantounias (2013).

TSH is rejected for the USA for the period 1947–1988 but not for 1929–1988. Olekalns (1997) investigates Australian data for the period 1964–1995 and rejects the TSH, whilst Cashin et al. (1998) use Indian data for the period 1951–1952 to 1996–1997 and discover evidence of tax-smoothing and tax-tilting. Cashin et al. (1998) test whether tax-smoothing behaviour is consistent with the fiscal policies of Pakistan and Sri Lanka using data from 1956–1995 and 1964–1997 respectively; they conclude that the TSH is rejected in the case of Sri Lanka but not for Pakistan. Olekalns and Crosby (1998) test the TSH for Australia, the UK, and the USA, revealing that tax-smoothing cannot be rejected only for the latter. Similarly, Serletis and Schorn (1999) find that the TSH cannot be rejected for Canada, France, the UK, or the USA for the period 1950:Q1–1995:Q2. Rocha (2001), exploring Brazilian data over the period 1970–1994, finds evidence against the TSH for the full sample. Strazicich (2002) uses panel unit root tests but could not reject the TSH for 19 industrialized economies for the period 1955–1988. Furthermore, Cashin et al. (2002) found that the TSH is rejected by Pakistani data for the period 1954–1995. Adler (2006) tests the TSH using the Swedish central government data and concludes that it is not possible to statistically reject the TSH for the full period 1952–1999, but that the TSH is rejected using the subsample period from 1970–1996. Reitschuler (2010) tests the TSH for the EU-15 countries over the period 1970–2006. He considers the effects of one structural break in the data, associated with the introduction of the Maastricht Treaty in 1993. With the exception of Germany and the Netherlands, the TSH is rejected for the rest of the countries before the break, while it is rejected for all EU-15 countries after it. In another study, Reitschuler (2011) investigates the existence of tax-smoothing for the new member states of the EU. In this study, the hypothesis is found to be valid for the Czech Republic, Hungary, Lithuania, Poland, and Romania and it is also shown that the tax-smoothing behaviour of these countries was not affected by the Maastricht fiscal rule. Additionally, Paster and Cover (2011) for Chile provide evidence in support of the TSH for the period 1973–2002. Jayawickrama and Abeysinghe (2013) use a direct method to test the existence of tax-smoothing for Australia, Canada, Italy, Japan, the Netherlands, New Zealand, the USA, and the UK. They also classify the forms of tax-smoothing into "no tax-smoothing", "weak form", and "strong form" for these countries. Their results are in favour of the weak form of tax-smoothing for all countries they analysed. Karakas et al. (2014) examine the existence of the TSH in the case of Turkey using data for the time period 1923–2011; their results imply that the TSH does not hold true for Turkey. Turan et al. (2014), using annual data for the period of 1949–2010 for Turkey, report evidence against the TSH. Pastén and Cover (2015), using data from a panel of 19 Latin-American countries for the period 1984–2009, present estimation results that strongly support the proposition that an increase in political risk increases the degree of tax-tilting.

More recently, Karakas and Turan (2020), using data from South Africa and Turkey for the periods 1977–2014 and 1980–2014 respectively, show that tax-tilting is common in both South African and Turkish fiscal policies but provide evidence against the existence of the TSH in the two countries. Finally, Angydiris and Michelis (2021) test TSH predictions using data for the period 1973–2017 from a sample of 22 OECD countries. When they account for structural breaks in the data, they find that the TSH is rejected in favour of stationary tax rates in five countries. Furthermore, for most countries with stationary tax rates, the debt-to-GDP ratio helps predict their expected future tax rates; this is not the case for the remaining countries whose tax rates appear to be nonstationary.

3. The tax-smoothing model of government finance

3.1 The model

In order to test the basic premises of the tax-smoothing model we follow Ghosh (1995), Olekalns (1997), and Adler (2006). We define the one-period government budget constraint by,

$$B_{t+1} = (1 + r)B_t + G_t - \tau_t Y_t \qquad (1)$$

In algebraic terms, let Bt be the real stock of government debt, Gt the real primary expenditures (i.e., excluding interest payments), Yt the real output, τt the average rate of tax at time t, Tt = τtYt the real government revenues, and r the (fixed) real interest rate.

Under the assumption that output grows at a fixed rate equal to n and dividing by output, the dynamic government budget restriction equation (1) can be rewritten as,

$$(1 + n)\, b_{t+1} = (1 + r)b_t + g_t - \tau_t \qquad (2)$$

with the lower-case letters denoting the ratio of respective variable to output.

Taking expectation of equation (2), solving for τt by recursive forward substitution, we obtain,

$$\sum_{i=t}^{\infty}\left(\frac{1}{1+R}\right)^{i-t} E_t\tau_i = \sum_{i=t}^{\infty}\left(\frac{1}{1+R}\right)^{i-t} E_t g_i + (1+r)b_t + \lim_{i\to\infty}\sum_{i=t}^{\infty}\left(\frac{1}{1+R}\right)^{i} E_t(1+n)b_{t+i} \qquad (3)$$

where R = (r – n)/(1 + n) is the effective net interest rate faced by the government and Et is the expectations operator, conditional on the government information set at time t.

Equation (3) shows that the net present value of expected tax rates must equal the sum of the net present value of expected government expenditure plus initial debt and the current value of future public debt. The condition for fiscal sustainability requires that the limit term in equation (3), i.e., the Transversality Condition (TC) of the intertemporal decision problem of the government, is equal to zero asymptotically. This is equivalent to the current value of future public debt being convergent to 0,

$$\lim_{i\to\infty}\sum_{i=t}^{\infty}\left(\frac{1}{1+R}\right)^{i} E_t(1+n)b_{t+i} = 0 \qquad (4)$$

Thus, the TC rules out a Ponzi scheme (whereby debt is perpetually rolled over) as the necessary condition for lenders to hold government bonds[2].

The basis for the tax-smoothing model of optimal fiscal policy is found in Campbell's (1987) model of consumption smoothing. In Campbell's model, risk-averse economic agents use their savings to smooth the path of consumption expenditures in the presence of predictable changes in their future income. In the tax-smoothing model it is the government, acting on behalf of its risk-averse agents, that undertakes the required smoothing using its borrowing (dissaving) and lending (saving) behaviour in the presence of predictable changes in its future expenditure.

The tax-smoothing model assumes that, in the absence of a first-best system of lump-sum taxes, the government seeks to minimize the welfare losses arising from its choice of tax rate. These losses are assumed to be an increasing, convex, and time invariant function of the average tax rate. Indeed, the government's ability to minimize the tax-induced distortions is conditioned by its adherence to the intertemporal budget constraint, which requires the present value of tax receipts to be sufficient to cover all current and future government spending together with the government's initial debt. In order to meet the intertemporal budget constraint, taxes therefore cannot remain invariant to changes in either current or expected future expenditure. However, welfare losses will be minimized if, in response to newly acquired information indicating a future change in government expenditure, the government smooths the implied tax change over time.

When a first-best system of lump-sum taxes does not exist, the government must seek to minimize the welfare losses that occur as a result of the choice of the tax rate. Following the presentation of Barro (1979), Ghosh (1995) and Olekalns (1997), the government's objective function is to maximize,

[2] For more details, see Esteve and Prats (2023).

$$V = -(1/2)\sum_{i=t}^{\infty} \beta^{i-t}\, E_t\left[\tau_i^2 \,\middle|\, I_t\right] \quad 0 < \beta < 1 \tag{5}$$

where β is the government's subjective discount rate reflecting the preference for current taxation over future taxation; It is the information set available to the government at time t; and distortionary costs are assumed to be proportional to the square of the average tax rate. The convexity of the tax rate means that agents favour a constant (smooth) tax rate over a variable rate yielding the same revenue. Assuming that $\beta = 1/(1 + R)$, the Euler equation implies that for any $j > t$,

$$E_t\, \tau_t = \tau_t \tag{6}$$

that is, the average rate of taxes follows a random walk[3].

From equations (3) and (6), we obtain the optimal budget policy as,

$$\tau_t = (r - n)b_t + \frac{R}{1+R}\sum_{i=t}^{\infty}\left(\frac{1}{1+R}\right)^{i-t} E_t g_i \tag{7}$$

According to equation (7), optimal budget policy implies that the tax rate should always be set equal to the annuity value of the sum of government debt and the net present value of expected government expenditure.

If we define the budget balance (surplus or deficit) as,

$$bal_t = (1 + n)\,(b_t - b_{t-1}) \tag{8}$$

then the dynamic government budget restriction in equation (2), henceforth referred to as the actual budget balance, balt, can be rewritten as,

$$bal_t = \tau_t - g_t - (r - n)b_t = \tau_t - gt_t \tag{9}$$

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[3] This is the first basic implication of the TSH, which has been tested empirically by several authors, with the most common results being that tax rates do actually follow a random walk. For example, see the seminal papers of Barro (1981) and Sahasakul (1986).

where gtt is total government expenditure, i.e., the sum of primary expenditure, gt, and (r – n)bt, the effective interest payment on government debt.

Substituting equation (7) into (9), we obtain the *optimal budget balance*, bal_t^o, as,

$$\mathrm{bal}_t^o = \sum_{i=t+1}^{\infty} \left(\frac{1}{1+R}\right)^{i-t} \mathrm{E}_t \; (\Delta \mathrm{gt}_i \mid \mathrm{I}_t \qquad (10)$$

Finally, according to equation (10), an optimal budget policy (a tax-smoothing government) – given that its discount rate equals the effective real interest rate – requires that, at any point, the budget balance must be equal to the discounted sum of all future expected changes in government expenditure, i.e., the government runs a budget surplus when expenditure is expected to increase, and vice versa.

3.2 Tax-smoothing vs. tax-tilting

There are two broad considerations motivating a government to run a budget deficit: tax-tilting and tax-smoothing. First, following equation (10), under tax-smoothing the optimal budget policy, deficits are temporary phenomena resulting from the decision to not vary the tax rate in response to fluctuations in government spending. This is done in order to minimize the distortionary cost of taxes. Specifically, tax-smoothing behaviour results in public deficits because in the presence of non-lump-sum taxes, optimizing governments seek to minimize the distortionary effects of taxation by keeping tax rates smooth over time, rather than varying contemporaneously with expenditure.

Second, other intertemporal incentives for running unbalanced budgets exist. Even if we assume that government spending as a share of GDP will remain constant into the future (in which case there would be no need for tax-smoothing), if the government's discount rate, β, differs from the effective interest rate, *R*, then the optimal tax rate will be affected by the government's desire to engage in tax-tilting[4]. If β < R, for instance,

[4] See Gosh (1955) for a discussion of tax-tilting.

the government would have a preference for shifting taxes into the future, i.e., lowering taxes today (resulting in a fiscal deficit) and then gradually raising taxes over time in order to lower the accumulated stock of debt. In other words, a tax-tilting budget optimal policy results in a bias towards either budget deficits or budget surpluses, which are created in a manner consistent with intertemporal fiscal solvency. On the contrary, if β > R, the government has an incentive to bring tax increases forward, run fiscal surpluses, build down its stock of liabilities and then gradually lower taxes over time.

Apart from a high government rate of time preference (which lowers the government's discount rate (β)), two other important reasons for fiscal deficit that result in tax-tilting are having periods with low real interest rates (r) and/or high economic growth rates (n), both of which raise the effective interest rate on public borrowings (R), with $R = (r - n)/(1+n)$.

3.3 Empirical implementation of the model

3.3.1 The tax-tilting parameter

As noted previously, tax-tilting has implications for the budget balance that are wholly different from tax-smoothing; it is thus fundamental to ensure that the optimal budget balance derived from equation (10) is compared to only that component of the budget balance that relates to tax-smoothing, and not to the actual budget balance from equation (9), which potentially includes both tax-smoothing and tax-tilting components. This can be achieved by filtering the tax-tilting component from the actual budget balance according to

$$bal_t^{sm} = \gamma^{-1}\tau_t - g_t - (r-n)b_t = \gamma^{-1}\tau_t - gt_t \qquad (11)$$

where $\gamma = [(1-(R/\beta)R/(1-R)]$ is the tilting parameter.

Hence, equation (11) refers only to the budget component that relates to the tax-smoothing, which we will henceforth refer to as the actual *tax smoothed budget balance*, bal_t^{sm}. For example, when $\beta < R$ (and so $\gamma < 1$) the actual tax-smoothed budget balance,

bal_t^{sm}, will be larger than the actual budget balance, bal_t, since the incentive is for the government to carry tax collections over into the future and so run a budget deficit in the present according to tax-tilting motivations. Under the assumption that bal_t^{sm} is stationary with or without structural changes, then γ^{-1} is the cointegrating parameter from a regression of gt_t on τ_t.

3.3.2 The derivation of the optimal budget balance

The second step is to calculate the optimal tax-smoothing component of the budget balance. The derivation of the optimal budget surplus (equation (10)) requires a measure of anticipated future changes to government expenditure. One approach is to use current and lagged changes in government spending to predict future changes in it. Following both Campbell (1987) and Campbell and Shiller (1987), a method of deriving such a measure is to exploit the fact that under the null hypothesis that tax smoothing is valid, the budget balance contains all the known information about future changes to the government's spending plans. Consequently, the budget balance should Granger-cause (help predict) future changes in government expenditure. Because the actual tax-smoothed budget balance, bal_t^{sm}, responds to expected future changes in government spending, Δgt_t, it is a relevant information variable for forecasting future changes in government expenditure. Thus, this forecast can be obtained from a first-order unrestricted bivariate VAR model of Δgt_t and bal_t^{sm} as,

$$\begin{bmatrix} \Delta gt_t \\ bal_t^{sm} \end{bmatrix} = \begin{bmatrix} \psi_1 & \psi_2 \\ \psi_3 & \psi_4 \end{bmatrix} \begin{bmatrix} \Delta gt_{t-1} \\ bal_{t-1}^{sm} \end{bmatrix} + \begin{bmatrix} \varepsilon_{\Delta gt_{t-1}} \\ \varepsilon_{bal_{t-1}^{sm}} \end{bmatrix} \quad (12)$$

The VAR (12) can be rewritten in matrix form as,

$$\mathrm{Z}_t = \Psi \mathrm{Z}_{t-1} + \epsilon_t \quad (13)$$

where $\mathrm{Z}_t = (\Delta gt_t, bal_t^{sm})'$, Ψ is the transition matrix of the VAR, and ϵ_t is a 2 x 1 vector of disturbance terms. The optimal forecast of Z_t k periods ahead, given $\{ Z_t, Z_{t-1}, \dots \}$, should satisfy $E_t Z_{t+k} = \psi^k Z_t$ for $k \geq 1$. Using this formula, the estimate of the optimal tax-smoothing component of the budget balance, we will henceforth refer to the optimal tax-smoothed budget balance, $b\hat{a}l_t^{osm}$, which can be computed as,

$$b\hat{a}l_t^{osm} = [1\ 0]\ R\widehat{\Psi}\left[I - R\widehat{\Psi}\right]_t^{-1} Z_t = \widehat{\Lambda} Z_t = \widehat{\Lambda}_1 \Delta gt_t + \widehat{\Lambda}_2 bal_t^{sm} \qquad (14)$$

where I is the 2 x 2 identity matrix and Λ is a 1 x 2 matrix of coefficients. Expression (14) is valid as long as both the infinite sum in equation (10) converges and the variables appearing in the Z_t matrix of the VAR system are stationary. Assuming that gt_t is I(1), Δgt_t will be I(0) or stationary. Since under the null the actual tax-smoothed budget balance, bal_t^{sm}, is equal to the optimal tax-smoothed budget balance, $b\hat{a}l_t^{osm}$, which from equation (10) is a discounted sum of Δgt_t, then bal_t^{sm} will also be I(0) or stationary.

If the TSH is true, *the optimal tax-smoothed budget balance*, $b\hat{a}l_t^{osm}$, is equal to *the actual tax-smoothed budget balance*, bal_t^{sm}, i.e., $\Lambda_1 = 0$ and $\Lambda_2 = 1$.

Once the optimal tax-smoothed budget balance, $b\hat{a}l_t^{osm}$, has been calculated, a number of tests may be performed to verify the empirical validity of the TSH: i) first, as observed previously, the model predicts that the *actual tax-smoothed budget balance*, bal_t^{sm}, should Granger-cause changes in government expenditure, Δgt_t; ii) second, by examining the joint parameter restriction $\Lambda_1 = 0$ and $\Lambda_2 = 1$ (using Wald's or LR-tests) and nonrejections of these restrictions, the model implies that movements in $b\hat{a}l_t^{osm}$ fully reflect movements in bal_t^{sm}; and iii) third, the above VAR model can also be used for informally evaluating the performance of the TSH. $b\hat{a}l_t^{osm}$ is the "theoretical" budget balance, that is, the optimal VAR forecast of the present value of future growth rates of government expenditures. Since bal_t^{sm} is included in the current information set, according to (10), under the TSH bal_t^{sm} should differ from $b\hat{a}l_t^{osm}$ only by sampling error. Therefore, the plausibility of the TSH can also be informally evaluated graphically by comparing the actual bal_t^{sm} with the predicted $b\hat{a}l_t^{osm}$.

4. Empirical results

The Spanish case proves to be of special interest in testing the TSH given the permanent difficulties experienced when balancing the government budget across years, and it is also an interesting case study among eurozone countries. Indeed, the

Spanish fiscal performance has been characterized by chronic government deficits and episodes with high levels of public debt, which is particularly dangerous when belonging to a monetary union.

As far as we know, only two studies have dealt with the issue of the TSH in the Spanish economy but using a short sample. Strazicich (2002) uses panel unit root tests and cannot reject the TSH for 19 industrialized economies (including Spain) for the period 1955–1988. Reitschuler (2010) tests the TSH for the EU-15 countries (including Spain) over the period 1970–2006, using the tests developed by Andrews and Kim (2006). Among other results, Reitschuler considers the effects of one structural break in the data, associated with the introduction of the Maastricht Treaty in 1993. With the exception of Germany and the Netherlands, the TSH is rejected for all countries before the break, while it is rejected for all EU-15 countries after it.

In our case, we analyse the possible optimality of the path followed by the budget balance of the Spanish economy over a very long period of 172 years (1850–2022).

4.1 Data

In our empirical analysis, we use data on the Spanish economy from two databases, from the periods 1850–2000 and 1964–2022. The length of these databases makes them especially suitable for the econometric approach adopted in this paper.

Firstly, we use data on the primary (i.e., excluding interest payments) budget surplus and total gross debt, as well as on total revenues and expenditures, all of them as percentages of GDP, for the Spanish central government (i.e., excluding social security and local and regional governments) over the period 1850–2000. Notice that only data for the central government are available for the whole period; in particular, data on local governments are unavailable until 1958: regional governments were established just after the approval of the current Constitution in 1978, and social security began to expand only after 1967.

The data on the public sector variables come from Comín and Díaz (2005), who provide a compilation of a large amount of government statistics for the period 1850–

2000. As pointed out by these authors, the quantitative sources for the Spanish public sector are, in general, both abundant and reliable. From 1850 onwards, after the issuing of a law on public accountancy in that year, all the revenues and expenditures of the Spanish central government have been registered until 1957 into the *Estadísticas de las Cuentas Generales del Estado* (Statistics of General Accounts of the State). After 1958, these *Estadísticas* collect information about the activities of the general government (i.e., also including local and – since the 1980s – regional governments, as well as social security), and are available through the *Cuentas de las Administraciones Públicas* (Accounts of the General Government) published by the Ministry of Finance. Finally, the data on GDP have been taken from Prados de la Escosura (2003), who has constructed series for the main macroeconomic variables of the Spanish economy over the period 1850–2000. The data are: a) the ratio of the central government's total revenues to GDP; b) the ratio of the central government's total expenditures to GDP.

Secondly, we use similar data on the Spanish general government (i.e., including social security and local and regional governments) and the GDP over the period 1964–2022, published by the Instituto Nacional de Estadística (INE) and Banco de España.

The time evolution of the ratio of the general government's total revenues to GDP and the ratio of the general government's total expenditures to GDP, over the period 1850–2000 and 1964–2022 is shown in Figures 1 and 2, respectively, and that of the actual budget balance over the period 1850–2000 and 1964–2022 in Figures 3 and 4, respectively. A more detailed account of the evolution of the Spanish public sector over this one-and-a-half-century period can be found in Bajo-Rubio et al. (2014), Comín (1995), Comín (1996), Comín (2012), Esteve and Tamarit (2018), or Tortella (2000).

Figure 1. Spanish central government revenues and expenditures
Carreras-Tafunell data, 1850-2000

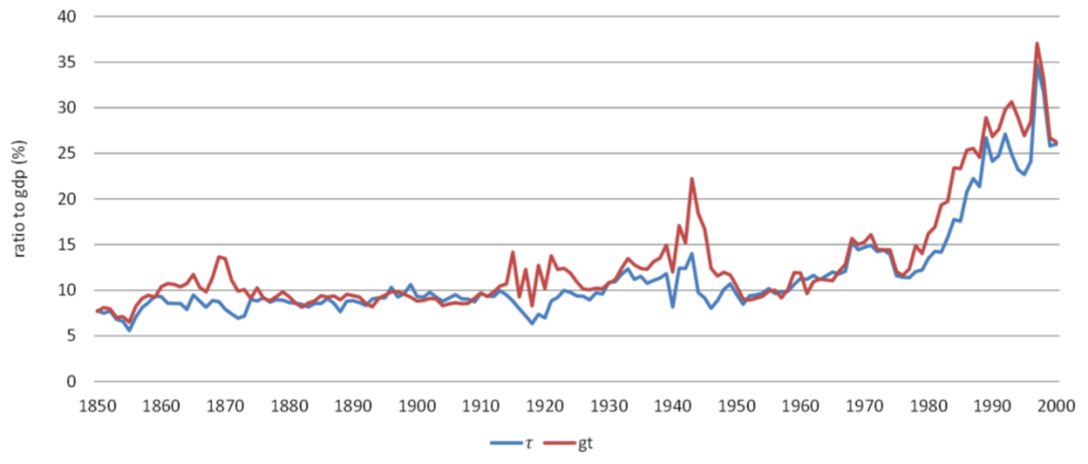


Figure 2. Spanish general government revenues and expenditures
INE-BE data, 1964-2022

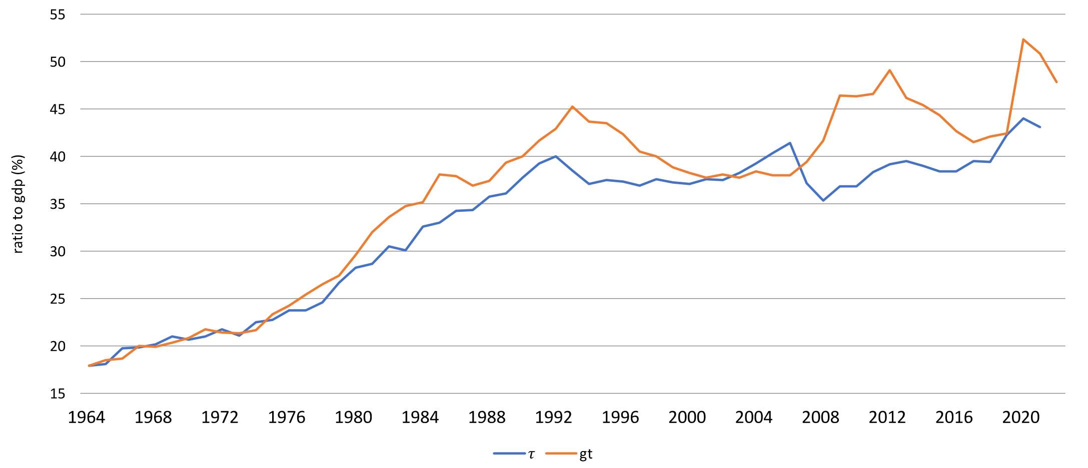


Figure 3. Spanish actual budget balance
Carreras-Tafunell data, 1850-2000

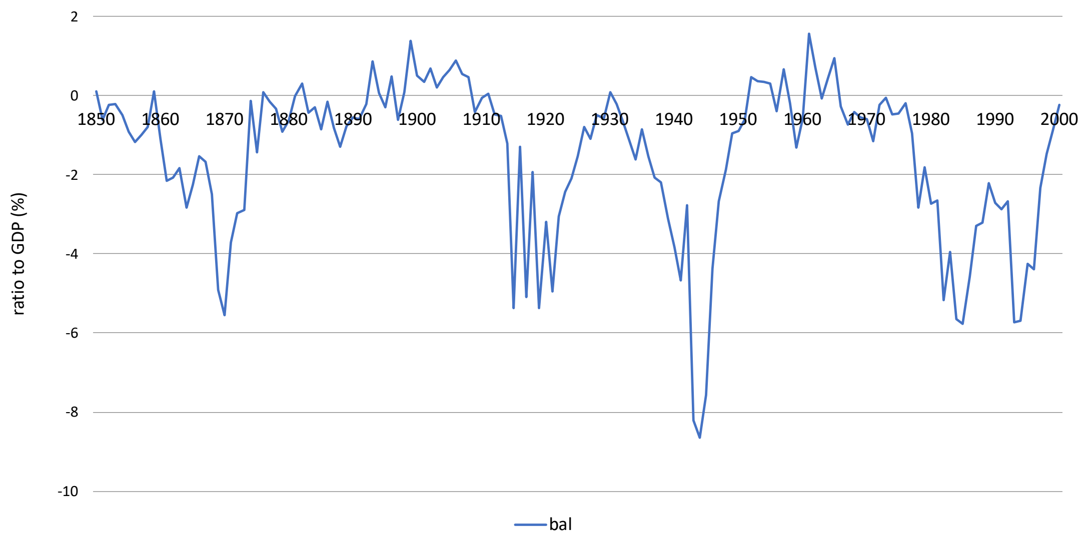
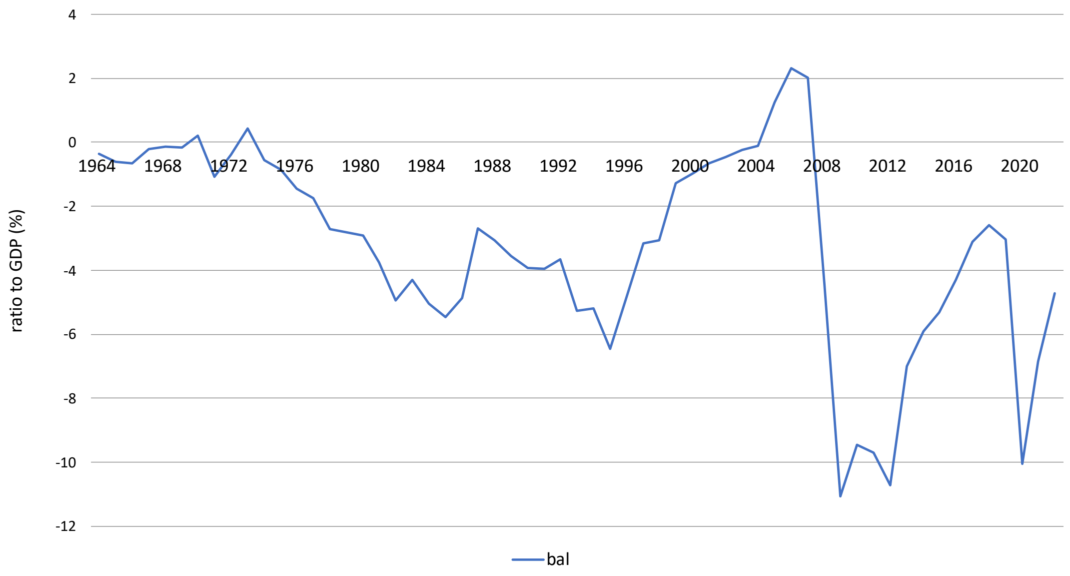


Figure 4. Spanish actual budget balance
INE-BE data, 1964-2022



4.2 Stationarity of the time series

The first step in our analysis is to examine the time series properties of the series by testing for a unit root over the full sample.

For the analysis of the order of integration, we have used the *M* unit root test proposed in Ng and Perron (2001). In general, the majority of the conventional unit root tests (DF and PP types) suffer from three problems. First, many tests have low power when the root of the autoregressive polynomial is close to, but less than, the unit (Dejong et al., 1992). Second, the majority of the tests suffer from severe size distortions when the moving-average polynomial of the first differences series has a large negative autoregressive root (Schwert, 1989; Perron and Ng, 1996). Third, the implementation of unit root tests often necessitates the selection of an autoregressive truncation lag, *k*. However, as discussed in Ng and Perron (1995), there is a strong association between *k* and the severity of size distortions and/or the extent of power loss. More recently, Ng and Perron (2001) proposed a methodology that solves these three problems. Their method consists of a class of modified tests, called M^{GLS}, originally developed in Stock (1999) as *M* tests, with GLS detrending of the data as proposed in Elliot et al. (1996), and using the Modified Akaike Information Criteria (*MAIC*). Also, Ng and Perron

(2001) have proposed a similar procedure[5] to correct for the problems of the standard Augmented Dickey–Fuller (ADF) test, ADF^{GLS}.

Table 1 shows the results of M unit root tests of Ng and Perron (2001). First, the null hypothesis of non-stationarity cannot be rejected for gt_t and τ_t at the 1% level of significance for both periods[6]. Second, the results reject the null hypothesis of non-stationarity for bal_t^{sm} at the 1% and 5% significance level, for the period 1850–2000 and for the period 1964–2022 respectively, as predicted by the TSH.

Table 1

M unit root tests of Ng and Perron (2001)[a,b]

Variable	MZ_{α}^{GLS}	MZ_t^{GLS}	MSB^{GLS}	MP_T^{GLS}	ADF^{GLS}
1850-2000					
gt_t	-6.93	-1.74	0.251	13.29	-1.63
τ_t	-8.54	-1.85	0.217	11.37	-1.77
bal_t^{sm}	-16.33^{***}	-3.82^{***}	0.172^{***}	1.63^{***}	-2.93^{***}
1964-2022					
gt_t					
τ_t					
bal_t^{sm}	-11.97^{**}	-2.43^{**}	0.203^{**}	2.08^{**}	-2.76^{***}

[a] Superscripts *,**,*** indicate significance at the 10%, 5%, and 1% levels respectively.

[b] The *MAIC* information criterion is used to select the autoregressive truncation lag, *k*, as proposed in Ng and Perron (2011). The critical values are taken from Ng and Perron (2001), table 1.

4.3 Long-run relationship

Once the order of integration of the series has been analysed, we estimate the long-run or cointegration relationship between gt_t and τ_t.

[5] See Ng and Perron (2001) and Perron and Ng (1996) for a detailed description of these tests.

[6] We base our analysis on the M^{GLS} unit root tests as they show a better performance in finite samples than the ADF^{GLS} test statistic.

We estimate and test the coefficients of the cointegration equation by means of the dynamic ordinary least squares (DOLS) method of Saikkonen (1991) and Stock and Watson (1993) and following the methodology proposed by Shin (1994). This estimation method provides a robust correction to the possible presence of endogeneity in the explanatory variables, as well as serial correlation in the error terms of the OLS estimation. Additionally, to overcome the problem of the low power in classical cointegration tests in the presence of persistent roots in the residuals from the cointegration regression, Shin (1994) suggests a new test in which the null hypothesis is that of cointegration. Therefore, in the first place, we estimate a long-run dynamic equation that includes the leads and lags of all the explanatory variables, i.e., the so-called DOLS regression,

$$gt_t = c + \Phi t + \gamma^{-1}\tau_t + \sum_{j=-q}^{q} \gamma_j^{-1}\,\Delta\tau_{t-j} + v_t \tag{15}$$

If there is cointegration in the demeaned specification given in (15), such cointegration would occur when $\Phi = 0$, which corresponds to deterministic cointegration and implies that the same cointegrating vector eliminates both the deterministic and stochastic trends. However, if the linear stationary combinations of $I(1)$ variables have nonzero linear trends (which occurs when $\Phi \neq 0$), as given in (15), this would correspond to a stochastic cointegration[7]. In both cases, the parameter γ^{-1} is the estimated long-run cointegrating coefficient between gt_t and τ_t.

The coefficient from the DOLS regression and the results of the Shin test are reported in Table 2 for both periods. First, for the period 1850–2000, the null of deterministic cointegration between gt_t and τ_t is not rejected at the 1% level, with an estimated value for γ^{-1} of 1.15. Moreover, the estimated coefficient is significantly different from zero at the 1% level. Second, for the period 1964–2022, we find similar results with an estimated value for γ^{-1} of 1.20 and significantly different from zero at the 1% level.

[7] See Ogaki and Park (1997) and Campbell and Perron (1991) for an extensive study of deterministic and stochastic cointegration.

Table 2

Estimation of long-run relationships: tests for cointegration from Stock and Watson (1993) and Shin (1994) [a, b, c, d]

Parameter estimates	1850-2000	1964-2022
c	-0.23	-3.93
	(2.345)	(5.370)
$1/\gamma$	1.15	1.20
	(0.229)	(0.144)
Test:		
C_μ	0.063	0.059

[a] Standard errors are in parentheses. An AR(2) error was used for the calculation of the standard errors.

[b] We choose q = INT ($T^{1/3}$) as proposed in Stock and Watson (1993).

[c] C_μ is LM statistics for cointegration using the DOLS residuals from deterministic cointegration, as proposed in Shin (1994). The null hypothesis of deterministic cointegration versus the alternative hypothesis of no deterministic cointegration.

[d] Superscripts *,**,*** indicate significance at the 10%, 5%, and 1% levels respectively. The critical values are taken from Shin (1994), table 1, from m = 1.

Since the value for γ^{-1} is well above one (and significantly so), it shows that tax-tilting has been very important for the Spanish government and is a symptom of the existence of a public deficit bias that has existed in Spanish public finances over the sample period. A value for γ^{-1} of 1.15 and 1.21, respectively, suggests that the component of the actual Spanish fiscal deficit attributable to tax-tilting is equivalent to forgoing between 15 and 20 percent of tax revenue in the near term, and subsequently to raising taxes over time to clear the stock of accumulated public debt.

These values of γ^{-1} for Spain far exceed the value of this parameter in previous empirical work for the developed countries of Australia (0.96) in Olekalns (1997), Canada (0.93) and the United States (0.94) in Ghosh (1995), and Denmark (1.09), Greece (0.22), Luxemburg (0.83), Portugal (0.80), and Sweden (1.13) in Reitschuler (2010). On the contrary, these values of γ^{-1} for Spain are below the value of this parameter in previous empirical work for India (1.40) in Cashin et al. (1998), for Pakistan (1.22) and

Sri Lanka (1.24) in Cashin et al. (1999), for Pakistan (1.22) in Cashin et al. (2002), and for Austria (1.59), Belgium (2.11), Germany (1.70), France (1.90), Ireland (2.07), Italy (1.35), the Netherlands (1.49), Finland (1.86), and the United Kingdom (1.58) in Reitschuler (2010). Moreover, our estimated values for γ^{-1} (1.15 and 1.21) are above the value of this parameter estimated for Spain (1.03) in Reitschuler (2010).

Some indication of the magnitude of the tax-tilting can be obtained from Figures 5 and 6, which plot the actual budget balance, bal_t, and the budget balance after the tilting component has been removed, actual tax-smoothed budget balance, bal_t^{sm}. The smoothed component has traditionally been in surplus, with the significant exceptions being the periods: 1861–1873, 1915–1925, 1937–1948, 1978–1986, and 1993–1996 for the Spanish central government (database 1850–2000, Figure 5), and more exceptional (and small deficits) for the Spanish general government in 2009–2012 (database 1964–2021, Figure 6).

Figure 5. Spanish actual budget balance and tax-smoothed actual budget balance
Carreras-Tafunell data, 1850-2000

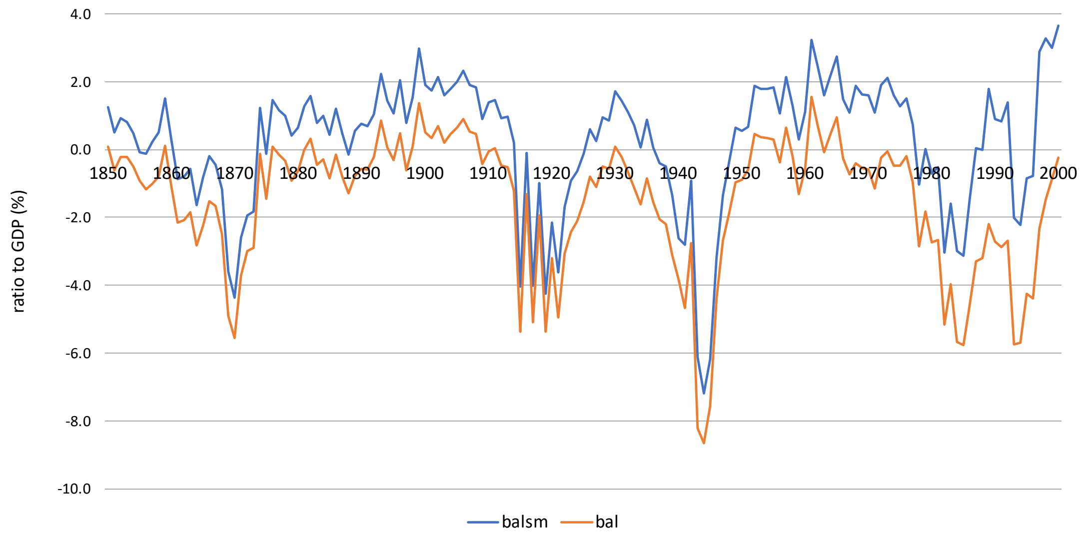
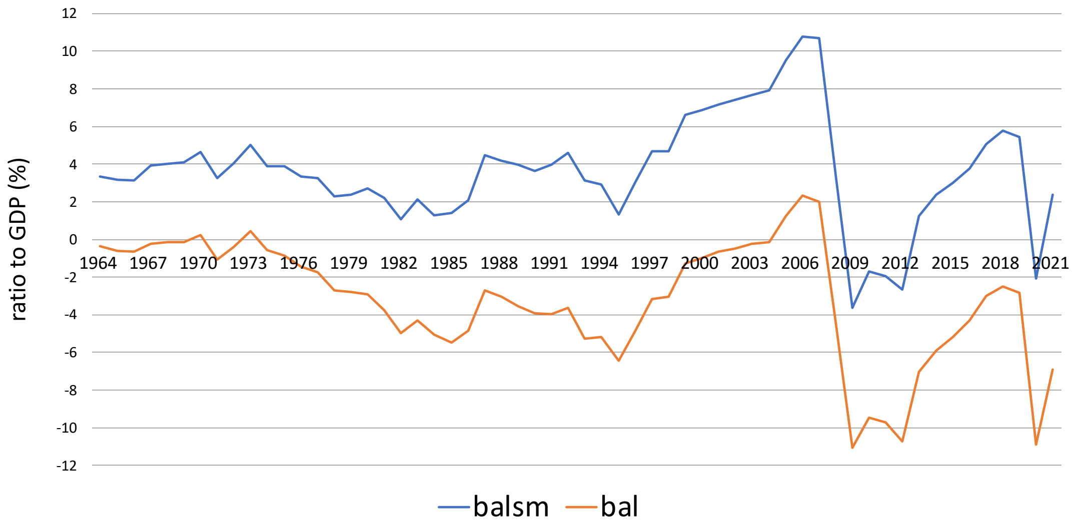


Figure 6. Spanish actual budget balance and tax smoothed budget balance
INE-BE data, 1964-2021



4.4 Bivariate VAR

We estimate the first-order unrestricted bivariate vector autoregression (VAR) for Δgt_t and bal_t^{sm} according to equation (12) and the results are displayed in Table 3. The number of lags in the VAR was identified using the Bayesian information criterion, and the optimal lag selected was one. The estimation method is ordinary least squares with the White correction of standard errors for heteroscedasticity (White, 1980).

Table 3

Estimation of a VAR for Δgt_t and bal_t^{sm} , [a, b]

	1850-2000		1964-2022	
	Δgt_t	bal_t^{sm}	Δgt_t	bal_t^{sm}
Δgt_{t-1}	-0.241	0.084	0.165	0.045
	(0.079)	(0.053)	(0.126)	(0.132)
bal_{t-1}^{sm}	0.109	0.794	0.136	0.900
	(0.077)	(0.052)	(0.056)	(0.058)
$[\widehat{\Lambda}_1, \widehat{\Lambda}_2]$	[-0.157, 0.903]		[0.210, 1.036]	

[a] Standard errors are in parentheses.

[b] The coefficients $\widehat{\Lambda}_1$ and $\widehat{\Lambda}_2$ are the estimated parameters from equation (14).

An implication of the TSH is that the budget surplus should Granger-cause (help predict) future changes in government spending. This will be true whenever the government has better information about the future path of its expenditure (through news of political or other events) than is contained in past values of the expenditure series. Under the null hypothesis that equation (10) holds, and so the budget surplus equals the discounted value of future changes in government expenditure (given the government's information set), then the surplus should take into account this additional information and so Granger-cause changes in government spending. On the one hand, for the period 1850–2000, the Wald test statistic (follows a χ_1^2 distribution) for the hypothesis that lagged values of the actual tax-smoothed budget balance, bal_{t-1}^{sm}, have no predictive power for current changes in government expenditure, Δgt_t, is 2.441 (p-value: 0.118), which implies that bal_{t-1}^{sm} does not Granger-cause Δgt_t. Therefore, the budget surplus does not have any information with regard to future changes in government expenditure, as predicted by the TSH. On the other hand, for the period 1964–2022, the Wald test statistic is 0.118 (p-value: 0.730), which implies that bal_{t-1}^{sm} does strongly Granger-cause Δgt_t. In this case, the budget surplus does have some information with regard to future changes in government expenditure, as predicted by the TSH. It is important to note that this analysis is preliminary and not sufficient for a final decision on the existence of tax smoothing behaviour.

Based on the results from the VAR estimation, we calculated the $\widehat{\Lambda}_1$ and $\widehat{\Lambda}_2$ parameters and the predicted *optimal tax-smoothed budget balance*, $b\hat{a}l_t^{osm}$, according to equation (14), which are shown in Table 3.

As discussed in the theoretical model, under the TSH, equation (14) requires Λ_1 and Λ_2 to be equal to zero and unity respectively. This is equivalent to a simple condition on the VAR transition matrix Ψ. Given that $b\hat{a}l_t^{osm}$ = [1 0] R$\widehat{\Psi}$ $\left[I - R\widehat{\Psi}\right]^{-1}_{t} Z_t$ and $b\hat{a}l_t^{osm} = bal_t^{sm}$ if [1 0] R$\widehat{\Psi}$ $\left[I - R\widehat{\Psi}\right]^{-1}_{t}$ Z_t = [0 1]. Post-multiplying by $\left[I - R\widehat{\Psi}\right]$ and adding [0 1] R$\widehat{\Psi}$ yields,

$$[1\ 0]\ R\widehat{\Psi} + \ [0\ 1]\ R\widehat{\Psi} = [0\ 1] \tag{16}$$

or

$$[1\ 1]\ R\widehat{\Psi} = [0\ 1] \tag{17}$$

Therefore, the sum of the elements of the first column of $R\widehat{\Psi}$ should be zero and the sum of the elements of the second column of $R\widehat{\Psi}$ should be 1. As R is approximately equal to 1 in the case of Spanish data, the sum of the elements of the first column of $\widehat{\Psi}$ should be approximately equal to zero, or $\psi_1 + \psi_3 \cong 0$, and the sum of the elements of the second column of $\widehat{\Psi}$ should be approximately equal to 1, or $\psi_2 + \psi_4 \cong 0$. We examine this restriction using Wald's test statistic distributed as χ_2^2.

According to Table 3, for the period 1850–2000, $\psi_1 + \psi_3 = -0.157$, which is significantly different from zero (p-value: 0.04), and $\psi_2 + \psi_4 = 0.903$, which is not significantly different from one (p-value: 0.2032). Therefore, the results are not conclusive. On the other hand, for the period 1964-2022, $\psi_1 + \psi_3 = 0.210$, which is significantly different from zero (p-value: 0.027), and $\psi_2 + \psi_4 = 0.377$, which is not significantly different from one (p-value: 0.3778). Therefore, the results are not conclusive either.

Next, we can compare the actual bal_t^{sm} with the predicted $b\hat{a}l_t^{osm}$ using the estimated values for $\widehat{\Lambda}_1$ and $\widehat{\Lambda}_2$ parameters (Figures 7 and 8). Despite the formal rejection of tax smoothing by the Wald test, the correspondence between the optimal and actual smoothed surpluses in Figure 7 and 8 is quite close, and therefore it would be far too strong to conclude that the data are completely inconsistent with the predictions of the tax-smoothing hypothesis. Accordingly, there is some evidence that Spain has engaged in tax-smoothing behaviour over the period analysed, in that it responded to expected future changes in government spending by running budget imbalances, rather than altering contemporaneous government revenue.

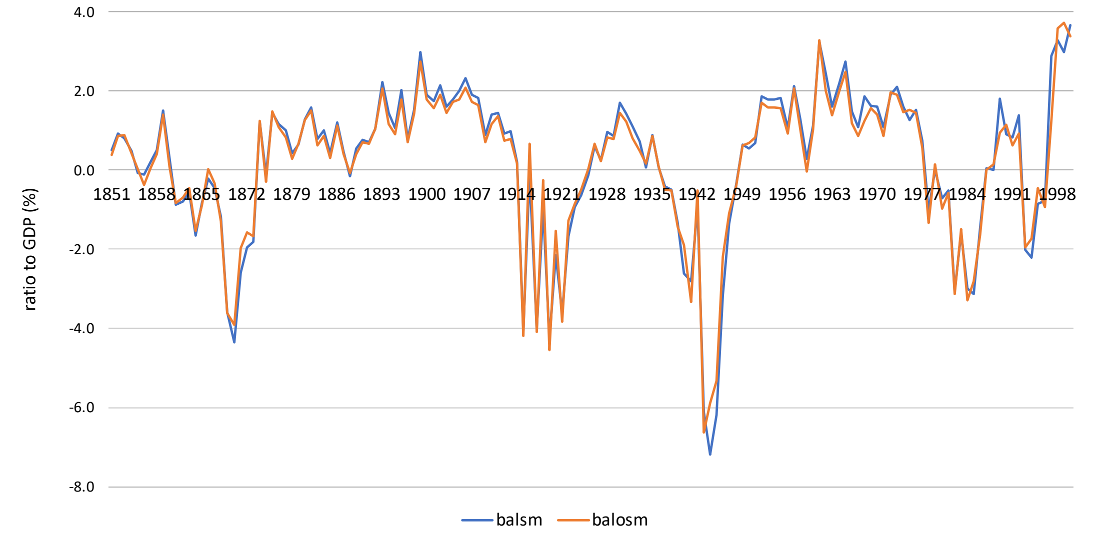


Figure 7. Spanish actual tax-smoothed budget balance and optimal tax-smoothed budget balance
Carreras-Tafunell data, 1851-2000

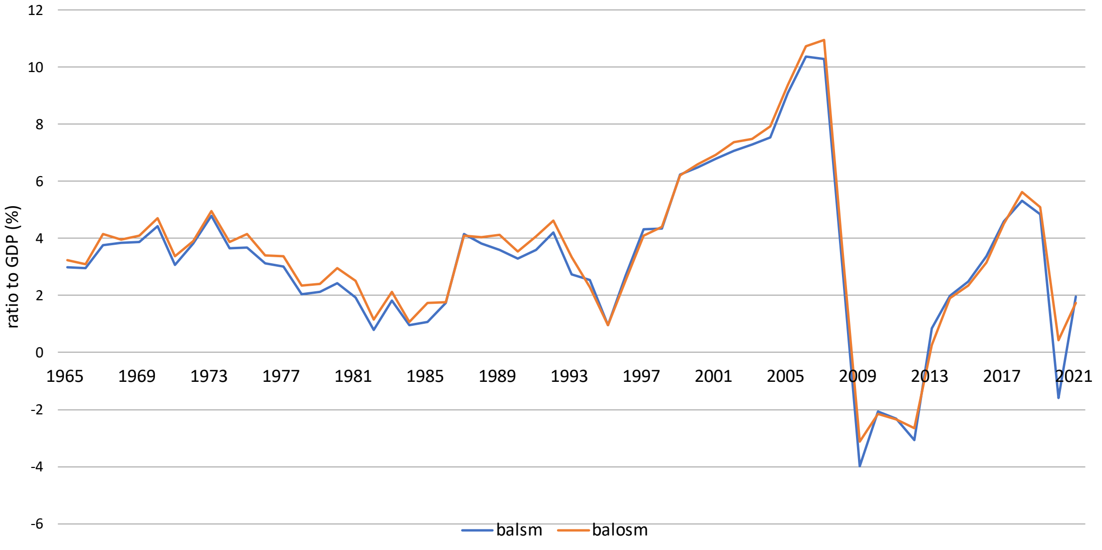


Figure 8. Spanish actual tax-smoothed budget balance and optimal tax-smoothed budget balance
INE-BE data, 1965-2022

Finally, there is only one clear divergence between the actual bal_t^{sm} and the predicted optimal path, $b\hat{a}l_t^{osm}$, for 2020, definitely due to the international economic crisis triggered by the COVID-19 pandemic.

5. Conclusions

In this paper, we provide a formal test of Barro's tax-smoothing model, using Spanish data covering the period 1850–2022. The Spanish case proves to be of special interest given the permanent difficulties experienced when balancing the government budget over time. There are two broad considerations motivating a government to run a deficit: tax-smoothing and/or tax-tilting. Tax-smoothing behaviour results in public deficits because in the presence of non-lump-sum taxes, optimizing governments seek to minimize the distortionary effects of taxation by keeping tax rates smooth over time, rather than varying contemporaneously with expenditure. Even if we assume that expenditures will remain constant over time, precluding the need for tax smoothing, fiscal deficits may arise due to tax-tilting behaviour if the government's discount rate differs from the effective interest rate, as then there is an incentive to tilt taxation over time.

On the one hand, we found that the value for γ^{-1} is well above one (and significantly so), showing that the tax-tilting component has been very important for the Spanish government and is a symptom of the existence of a public deficit bias that has existed in Spanish public finances throughout the sample period. A value for γ^{-1} of 1.15 and 1.20, for the 1850–2000 and the 1964–2022 periods respectively, suggests that the component of the actual Spanish fiscal deficit attributable to tax-tilting is equivalent to forgoing between 15 and 20 percent of tax revenue in the near term, and subsequently to raising taxes over time to clear the stock of accumulated public debt. The tax-tilting component supposes that the Spanish government should levy low taxes in the present and (implicitly) higher taxes in the future so that intertemporal solvency can be satisfied. In the Spanish economy context, this requires that, at some future point in time, taxes will need to be raised and fiscal surpluses (or smaller fiscal deficits) will need to be run to service the government's stock of liabilities. In fact, higher tax-tilting parameters are associated with higher subjective discount rates for Spanish governments compared to market interest rates. Thus, the Spanish economy tends to shift the burden of taxation away from the present while running budget deficits. In other words, the country accumulates debt to cover government expenditures earlier in time and, later in the future, it levies higher taxes to pay debts.

On the other hand, we provide a formal test of the tax-smoothing hypothesis. Our empirical findings do also support the existence of tax-smoothing in Spanish fiscal policy in both periods, as the Spanish governments responded to expected future changes in government spending by running budget imbalances, rather than altering contemporaneous government revenues.

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